

CODE READING SYSTEM FOR IDENTIFICATION OF MOVING AND STATIONARY OBJECTS UTILIZING NONCOHERENT OPTICS

This application is a continuation-in-part of copending patent application, Ser. No. 770,241, filed Oct. 24, 1968, entitled "Code Reading System," now abandoned.

The present invention relates to a new and improved optical system for identifying moving or stationary coded objects from which coded light images are transformed into either identifiable sine transforms or identifiable cosine transforms using noncoherent optics.

Material handling includes the management of quantities of objects such as moving or stationary crates, railroad cars, goods, and inventory items and it is important that pertinent information, such as the location, contents, destination, and other identification concerning these objects, be readily available. In the case of crates, goods and inventory items, such information enables their expedient storage and retrieval and the maintenance of an accurate up-to-date inventory to provide for efficiency and economy of operation. Regarding railroad cars and other moving or rolling stock, the availability of such data can provide information regarding the progress, location and contents of a particular car, train or truck, and the availability of empty cars and the expeditious maintenance of equipment and rolling stock. Acquisition of such pertinent information is sometimes made difficult because many of these objects have a similar or not easily recognizable external appearance.

As a consequence, any identification system should meet at least the following criteria. The means for reading a code identifying the objects or their contents should at least be capable of automatic retro-directive operation and perform with sufficient rapidity and flexibility to detect a non-moving code as well as a code moving at velocities exceeding, for example, 80 miles per hour. The code itself should be made of durable materials capable of withstanding all weather and wear conditions. Additionally, an optical code reader should be economical to build, contain no moving parts so as to be easy to install, maintain and adjust, and be insensitive to diverse weather conditions, level and kind of illumination and to the distance between the code and the code reader. Furthermore, the code itself and the output of the reader should be easily recognized by an unskilled operator.

A number of different systems have been devised to provide for the automatic generation of inventory and rolling stock data; however, they have not been entirely successful in meeting the above-stated preferred characteristics. For example, one prior optical system utilizes color coding techniques. The use of colored indicia as coded designators, however, requires considerable maintenance because the colored indicia are highly susceptible to bleaching as a result of constant exposure to sunlight and diverse weather conditions. Another system involves mechanisms utilizing coherent light sources and optical readers having costly, complex rotating mirror and lens assemblies which are not well suited for unattended outdoor operation over an extended period of time. A further system employs correlation techniques wherein masking devices are used

to detect the presence of particular coded characters. These systems have generally had the shortcoming of being able to operate only with objects having low passing velocities. Additionally, accurate positioning is necessary to provide successful operation. Such systems are further handicapped for employment with railroad cars which are characteristically subject to a lateral rocking or swaying motion.

The present invention overcomes and avoids these and other problems by providing an optical reading system which operates essentially in a passive manner, which has no moving parts, and which is capable of automatically reading coded indicia regardless of direction of traversal of either a moving object or a moving reader. To this end, the present invention, when employed to provide inventory or railroad car information, presents the advantage of an economical, durable reader that is easy to install, maintain and operate over extended periods of time under all weather conditions, and that will perform in conjunction with coded which are stationary or have having high passing velocities.

Briefly described, the present invention includes an optical system operating as close to the geometrical optics limit as is practically feasible for automatically reading coded indicia located on stationary and moving objects to be identified. As a corollary, the reader may be moved across stationary objects, such as railway cars parked in a car yard.

More particularly, the desired identification of the objects is accomplished by the use of coded reflective markers or labels placed on each of the objects to be identified. Preferably, the markers comprise a composite or series of bar patterns having specific widths and orientations according to an identification code. Spatially incoherent light from an extended source is reflected from the markers to produce input images which are automatically read by an optical code reader located at a reading station. Specifically, The optical code reader includes an optical transformer including a pair of Fresnel zone transparencies. When the spatially incoherent light from the source is reflected from the markers, the light is modulated in accordance with the marker pattern to provide input light images. These input images are then directed through the Fresnel zone transparencies which transform the images in such a manner as to produce output signals corresponding to the optical Fourier transforms of the input image signals. These output Fourier transform signals are formed in an output plane where they are detected by an appropriate number of suitably positioned photo-sensing devices.

In the prior art, coherent light has been passed through a Fresnel zone plate in such a manner as to cause the Fresnel zone to act as a lens. The light images thereby produced may be superficially compared to those produced by the present invention, but, in reality, are quite different because their production results from the use of diffraction techniques based upon Fraunhofer, coherent optics principles. Diffraction techniques are generally more expensive, cumbersome, and difficult to use due to the critical parameters of the required components. Diffraction techniques require the use of monochromatic light which is projected through the combination of a transparency capable of